on such areas of the semiconductor wafer which tend to be excessively polished. Rather than defining such recesses 1*b* in the turntable 1, any of the actuators shown in FIGS. 14 through 17 may be arranged so as to operate backwards to form recesses in the surface of the abrasive cloth 4 which is held in contact with the semiconductor wafer. Specifically, the movable plates 23, 29, 35 (see FIGS. 14, 15, 16) may be lowered or a negative pressure may be developed in the cavities 21 (see FIG. 17) to form recesses in the surface of the abrasive cloth 4.

FIG. 22 is an enlarged fragmentary vertical cross-sectional view of a polishing apparatus according to still another embodiment of the present invention. According to the embodiment shown in FIG. 22, a turntable 1 has recesses 1*b* defined in an upper surface thereof. The recesses 1*b* are filled with elastic members 40, and an abrasive cloth 4 is attached to the upper surface of the turntable 1. The polishing apparatus shown in FIG. 22 operates in substantially the same manner as the polishing apparatus shown in FIG. 21. Specifically, the abrasive cloth 4 has a weaker polishing ability at locations corresponding to the elastic members 40 disposed in the recesses 1*b* than other areas, and hence a semiconductor wafer is polished to a smaller degree at such locations by the abrasive cloth 4 held in contact with the semiconductor wafer. The elastic members 40, which are typically made of rubber, have a thickness which is the same as the depth of the recesses 1*b* such that the elastic members 40 have respective upper surfaces in the same plane as the upper surface of the turntable 1.

A polishing apparatus according to still another embodiment of the present invention will be described below.

The polishing apparatus according to this embodiment has actuators disposed in a turntable for selectively forming corresponding projecting regions on an upper surface of the turntable. Each of the actuators may be an electromagnetic actuator such as shown in FIG. 14 for selectively forming a projecting region under electromagnetic forces. Specifically, when an electric current is supplied to the actuator, the actuator forms a projecting region on the upper surface of the turntable. When the supply of an electric current is stopped, the upper surface of the turntable returns to a flat shape. Therefore, the actuator can selectively form a projecting region on the upper surface of the turntable.

The actuators may be arranged to form projecting regions in the pattern shown in FIG. 13.

When an actuator passes over the lower surface of a semiconductor wafer while the semiconductor wafer is being polished, the actuator follows the path as shown in FIG. 6. If a projecting region is formed on the upper surface of the turntable by the actuator at all times, then the projecting region acts on the semiconductor wafer along the entire path, i.e., the semiconductor wafer is polished more positively along the entire path by the projecting region than in other areas of the semiconductor wafer.

If the path is divided into smaller areas, then it is possible to control the polishing rate in each of such smaller areas. In order to achieve such a selective polishing action, the actuator is selectively operated to form a projecting region in a portion of the path while the actuator is moving over the lower surface of the semiconductor wafer.

FIG. 23 shows areas in which a projecting region acts and does not act when an actuator is turned on and off along a path. In FIG. 23, while the actuator is moving along a path $L_{OFF}$, the actuator is turned off, and no projecting region is formed on the turntable. Therefore, no polishing action is produced by any projecting region while the actuator is moving along the path $L_{OFF}$. Then, while the actuator is moving along a path $L_{ON}$, the actuator is turned on to form a projecting region on the turntable. Now, the projecting region acts on a semiconductor wafer in an area along the path $L_{ON}$, which is smaller than the area that is developed all along the path when the actuator is turned on at all times.

When a projection area is selectively formed in a portion of the path along which the actuator moves, the polishing action can be controlled in a finely adjusted manner.

The actuator may be turned on momentarily at any spot on the path. In such a case, a projecting region formed on the turntable by the actuator acts on the semiconductor wafer only in the area of the momentarily produced projecting region. With such momentary operation of the actuator, it is possible to polish the semiconductor wafer more intensively at a certain spot by synchronizing the rotational speeds of the semiconductor wafer and the turntable with each other.

The time at which the actuator is to be turned on may be determined by detecting the angular displacement of the turntable with a rotary encoder and determining whether the actuator is positioned below the semiconductor wafer.

While the selective formation of a projection area on the turntable has been described in this embodiment, a recess can also selectively be formed in the turntable in the same manner as described above.

Although certain preferred embodiments of the present invention have been shown and described in detail, it should be understood that various changes and modifications may be made therein without departing from the scope of the appended claims.

What is claimed is:

1. A polishing apparatus comprising:

a turntable;

an abrasive cloth mounted on an upper surface of said turntable;

a top ring disposed above said turntable for supporting a workpiece to be polished and pressing the workpiece against said abrasive cloth;

moving means for moving said turntable and said top ring relative to each other, thereby to cause said abrasive cloth supported by said turntable to polish a surface of the workpiece pressed by said top ring against said abrasive cloth, during which polishing at least one area of the surface of the workpiece tends to be polished more intensively at a higher polishing rate than at least one other area of the surface of the workpiece, thus tending to create polishing irregularities on the surface of the workpiece; and

said abrasive cloth having an actuatable region operable to be selectively caused to form therein a recess, and said recess being located at a position relative to said top ring to come into contact with the at least one area of the surface of the workpiece and thus forming means to perform less intensive polishing of the at least one area, while a region of said abrasive cloth other than at said recess is operable to contact the at least one other area of the surface of the workpiece to perform a more intensive polishing thereof, and thereby to correct the polishing irregularities.

2. A polishing apparatus according to claim 1, wherein said position of said recess is selectable in a radial direction of said turntable.

3. An apparatus for polishing a semiconductor wafer to a flat mirror finish, said apparatus comprising:

a turntable having an abrasive cloth mounted on an upper surface thereof;

a top ring disposed above said turntable for supporting a wafer to be polished and for pressing the wafer against said abrasive cloth, said top ring having a lower wafer-holding area against which the wafer is held during pressing thereof against said abrasive cloth;

moving means for moving said turntable and said top ring relative to each other, thereby to cause said abrasive cloth supported by said turntable to polish a surface of the wafer pressed by said top ring against said abrasive cloth, during which polishing areas of the surface of the wafer tend to be polished less intensively at a lower polishing rate than at least one other area of the surface of the wafer, thus tending to create polishing irregularities on the surface of the wafer; and

means for polishing the areas of the surface of the wafer more intensively than the at least one other area of the surface of the wafer and thereby to correct the polishing irregularities thereof, said means comprising:

cavities defined in said upper surface of said turntable;

members mounted in said cavities for movement therein to positions to project above said upper surface of said turntable and to cause portions of said abrasive cloth to project upwardly as a projecting regions;

said projecting regions each having a dimension in a radial direction of said turntable that is smaller than a diameter of said wafer-holding area of said top ring;

said projecting regions being located at positions relative to said top ring to come into greater contact with the areas of the surface of the wafer than with the at least one other area of the surface of the wafer; and

said members being individually and independently operable.

4. An apparatus for polishing a semiconductor wafer to a flat mirror finish, said apparatus comprising:

a turntable having an abrasive cloth mounted on an upper surface thereof;

a top ring disposed above said turntable for supporting a wafer to be polished and for pressing the wafer against said abrasive cloth, said top ring having a lower wafer-holding area against which the wafer is held during pressing thereof against said abrasive cloth;

moving means for moving said turntable and said top ring relative to each other, thereby to cause said abrasive cloth supported by said turntable to polish a surface of the wafer pressed by said top ring against said abrasive cloth, during which polishing areas of the surface of the wafer tend to be polished less intensively at a lower polishing rate than at least one other area of the surface of the wafer, thus tending to create polishing irregularities on the surface of the wafer; and

means for polishing the areas of the surface of the wafer more intensively than the at least one other area of the surface of the wafer and thereby to correct the polishing irregularities thereof, said means comprising:

cavities defined in said upper surface of said turntable;

means for supplying compressed air into said cavities to cause portions of said abrasive cloth to project upwardly above said upper surface of said turntable as projecting regions;

said projecting regions each having a dimension in a radial direction of said turntable that is smaller than a diameter of said wafer-holding area of said top ring;

said projecting regions being located at positions relative to said top ring to come into greater contact with the areas of the surface of the wafer than with the at least one other area of the surface of the wafer; and

said projecting regions being individually and independently operable.

5. An apparatus for polishing a semiconductor wafer to a flat mirror finish, said apparatus comprising:

a turntable having an abrasive cloth mounted on an upper surface thereof;

a top ring disposed above said turntable for supporting a wafer to be polished and for pressing the wafer against said abrasive cloth, said top ring having a lower wafer-holding area against which the wafer is held during pressing thereof against said abrasive cloth;

moving means for moving said turntable and said top ring relative to each other, thereby to cause said abrasive cloth supported by said turntable to polish a surface of the wafer pressed by said top ring against said abrasive cloth, during which polishing areas of the surface of the wafer tend to be polished more intensively at a higher polishing rate than at least one other area of the surface of the wafer, thus tending to create polishing irregularities on the surface of the wafer; and

means for polishing the areas of the surface of the wafer less intensively than the at least one other area of the surface of the wafer and thereby to correct the polishing irregularities thereof, said means comprising:

cavities defined in said upper surface of said turntable;

members mounted in said cavities for movement therein to positions inwardly of said upper surface of said turntable and to form recesses therein;

said recesses each having a dimension in a radial direction of said turntable that is smaller than a diameter of said wafer-holding area of said top ring;

said recesses being located at positions relative to said top ring to come into greater contact with the areas of the surface of the wafer than with the at least one other area of the surface of the wafer; and

said members being individually and independently operable.

6. An apparatus for polishing a semiconductor wafer to a flat mirror finish, said apparatus comprising:

a turntable having an abrasive cloth mounted on an upper surface thereof;

a top ring disposed above said turntable for supporting a wafer to be polished and for pressing the wafer against said abrasive cloth, said top ring having a lower wafer-holding area against which the wafer is held during pressing thereof against said abrasive cloth;

moving means for moving said turntable and said top ring relative to each other, thereby to cause said abrasive cloth supported by said turntable to polish a surface of the wafer pressed by said top ring against said abrasive cloth, during which polishing areas of the surface of the wafer tend to be polished less intensively at a lower polishing rate than at least one other area of the surface of the wafer, thus tending to create polishing irregularities on the surface of the wafer; and

means for polishing the areas of the surface of the wafer more intensively than the at least one other area of the surface of the wafer and thereby to correct the polishing irregularities thereof, said means comprising:

a surface of said abrasive cloth having a non-projecting region and projecting regions extending upwardly from said non-projecting region;

said projecting regions each having a dimension in a radial direction of said turntable that is smaller than a diameter of said wafer-holding area of said top ring;

said projecting regions having a height and being located at positions relative to said top ring to come into contact with the areas of the surface of the wafer, while said non-projecting region comes into contact with the at least one other area of the surface of the wafer; and

said projecting regions being individually and independently operable to project above said non-projecting region.

7. A polishing apparatus according to claim 6, wherein said abrasive cloth has a plurality of projecting regions, at least one of number or size on said projecting regions being selectable.

8. A polishing apparatus according to claim 6, wherein said projecting region has an adjustable height.

9. A polishing apparatus according to claim 6, wherein an upper surface of said turntable has a projecting region forming said projecting region of said abrasive cloth.

10. A polishing apparatus according to claim 6, wherein said projecting region has a circular shape.

11. A polishing apparatus according to claim 6, wherein said projecting region is annular.

12. A polishing apparatus according to claim 6, wherein said position of said projecting region is selectable in a radial direction of said turntable.

13. An apparatus for polishing a semiconductor wafer to a flat mirror finish, said apparatus comprising:

a turntable having an abrasive cloth mounted on an upper surface thereof;

a top ring disposed above said turntable for supporting a wafer to be polished and for pressing the wafer against said abrasive cloth, said top ring having a lower wafer-holding area against which the wafer is held during pressing thereof against said abrasive cloth;

moving means for moving said turntable and said top ring relative to each other, thereby to cause said abrasive cloth supported by said turntable to polish a surface of the wafer pressed by said top ring against said abrasive cloth, during which polishing areas of the surface of the wafer tend to be polished more intensively at a higher polishing rate than at least one other area of the surface of the wafer, thus tending to create polishing irregularities on the surface of the wafer; and

means for polishing the areas of the surface of the wafer less intensively than the at least one other area of the surface of the wafer and thereby to correct the polishing irregularities thereof, said means comprising:

recesses formed in said upper surface of said turntable, said recesses being covered by said abrasive cloth;

said recesses each having a dimension in a radial direction of said turntable that is smaller than a diameter of said wafer-holding area of said top ring;

said recesses being located at positions relative to said top ring such that portions of said abrasive cloth covering said recesses come into contact with the areas of the surface of the wafer, while a region of said abrasive cloth other than said portions covering said recesses comes into contact with the at least one other area of the surface of the wafer; and

said portions of said abrasive cloth covering said recesses being individually and independently operable.

14. A polishing apparatus according to claim 13, wherein said turntable has a plurality of recesses, at least one of number and size of said recesses being selectable.

15. A polishing apparatus according to claim 13, wherein said recess has an adjustable depth.

16. A polishing apparatus according to claim 13, wherein said recess has a circular shape.

17. A polishing apparatus according to claim 13, wherein said recess is annular.

18. A polishing apparatus according to claim 13, wherein said position of said recess is selectable in a radial direction of said turntable.

19. An apparatus for polishing a semiconductor wafer to a flat mirror finish, said apparatus comprising:

a turntable having an abrasive cloth mounted on an upper surface thereof;

a top ring disposed above said turntable for supporting a wafer to be polished and for pressing the wafer against said abrasive cloth, said top ring having a lower wafer-holding area against which the wafer is held during pressing thereof against said abrasive cloth;

moving means for moving said turntable and said top ring relative to each other, thereby to cause said abrasive cloth supported by said turntable to polish a surface of the wafer pressed by said top ring against said abrasive cloth, during which polishing areas of the surface of the wafer tend to be polished less intensively at a lower polishing rate than at least one other area of the surface of the wafer, thus tending to create polishing irregularities on the surface of the wafer; and

means for polishing the areas of the surface of the wafer more intensively than the at least one other area of the surface of the wafer and thereby to correct the polishing irregularities thereof, said means comprising:

said abrasive cloth having a non-projecting region and actuatable regions operable to be selectively caused to project upwardly from said non-projecting region as projecting regions;

said projecting regions each having a dimension in a radial direction of said turntable that is smaller than a diameter of said wafer-holding area of said top ring;

said projecting regions each having a height and being located at positions relative to said top ring to come into contact with the areas of the surface of the wafer, while said non-projecting region comes into contact with the at least one other area of the surface of the wafer; and

said actuatable regions being individually and independently operable.

20. A polishing apparatus according to claim 19, wherein said position of said projecting region is selectable in a radial direction of said turntable.

21. An apparatus for polishing a semiconductor wafer to a flat mirror finish, said apparatus comprising:

a turntable having an abrasive cloth mounted on an upper surface thereof;

a top ring disposed above said turntable for supporting a wafer to be polished and for pressing the wafer against said abrasive cloth, said top ring having a lower wafer-holding area against which the wafer is held during pressing thereof against said abrasive cloth;

moving means for moving said turntable and said top ring relative to each other, thereby to cause said abrasive cloth supported by said turntable to polish a surface of the wafer pressed by said top ring against said abrasive cloth, during which polishing at least one area of the surface of the wafer tends to be polished more intensively at a higher polishing rate than at least one other

area of the surface of the wafer, thus tending to create polishing irregularities on the surface of the wafer; and

means for polishing the at least one area of the surface of the wafer less intensively than the at least one other area of the surface of the wafer and thereby to correct the polishing irregularities thereof, said means comprising:

an annular recess formed in said upper surface of said turntable, said recess being covered by said abrasive cloth;

said annular recess having a dimension in a radial direction of said turntable that is smaller than a diameter of said wafer-holding area of said top ring; and

said annular recess being located at a position relative to said top ring to come into contact with the at least one area of the surface of the wafer, while a region of said abrasive cloth other than that covering said annular recess comes into contact with the at least one other area of the surface of the wafer.

* * * * *

22. A polishing apparatus for polishing a semiconductor wafer to a flat mirror finish, said apparatus comprising:

an abrasive cloth having a contact surface which contacts a surface of a wafer to be polished during polishing; and

a top ring for supporting the wafer and pressing the wafer against said abrasive cloth;

wherein a plurality of portions of said abrasive cloth are individually and independently pressed against the wafer by air pressures.

23. A polishing apparatus according to claim 22, further comprising a plurality of passages supplying the air pressures to said plurality of portions and being connected to respective regulators;

wherein said regulators control individually and independently the air pressures.

24. A polishing apparatus according to claim 23, further comprising a plurality of cavities corresponding to said plurality of portions of said abrasive cloth and connected to said passages respectively.

25. A polishing apparatus according to claim 22, wherein said abrasive cloth is pressed against the wafer by air pressure through a thin plate.

26. A method for polishing a semiconductor wafer to a flat mirror finish, said method comprising:

providing an abrasive cloth having a contact surface which contacts a surface of a wafer to be polished during polishing;

supporting the wafer and pressing the wafer against said abrasive cloth by a top ring; and



pressing a plurality of portions of said abrasive cloth against the wafer individually and independently by air pressures.